AL HAJAR

Geological Society of Oman
Quarterly Newsletter

Eighth Edition March 2006

President's message

As our term of office with the GSO draws to a close (May 2006), allow me to take this opportunity to thank the current members of the Executive Committee for their dedication, hard work and support. I thank the: Vice President Dr. Badr Al-Barwani, Executive Director Dr. Nadia Al-Abry, Secretary Dr. Mohammed Al-Mazrui, Treasurer Mr. Harub Al-Hinai, Editors Dr. John Aitken and Mr. John Willoughby, Membership Chairman Mr. Talal Al-Musallami and Committee Member Mr. Adil Al-Kiyumi. I would also like to thank all our GSO members and generous sponsors. On behalf of all on the Executive Committee, please know that it has been our true honor and pleasure to serve the membership of the GSO.

Disseminating scientific knowledge has always been a key topic in GSO's activities. During 2004-2006, the GSO concentrated its efforts on its core business, stimulating scientific communication among geoscientists and with the wider community through numerous seminars, fieldtrips and school visits. Our house journal Al-Hajar further improved its professional and scientific status. Priority was given to improve our image and exposure through local and international activities. One of our boldest steps so far to get a better exposure for Oman's geological heritage was GSO's participation in presenting a paper in 2005 in the System Earth-Biosphere Coupling conference in Germany.

International cooperation has become a strong issue for many geoscientific organisations today. This is partly due to reduced funding options, and partly to the realization that it is very difficult to get diversified messages across to our target organisations, which generally demand very brief descriptions supported by large communities. Developed countries have illustrated with full conviction that partnership with sister societies is essential to better utilise resources and meet their goals. With this in mind, the GSO strongly believes that priority in the coming years should be given to cooperation between geoscience societies in the region.

Finally, the GSO like many of its sister societies in the region is a non-profitable society. In order to continue to serve its members through its short- and long-term programs, the need to collaborate with others to identify and cultivate new donors and to raise the level of participation of existing contributors is crucial to achieve sustainability.

Omar Al-Ja'aidi
GSO President

What's inside

Note from the Editor

At last, I hear you say, the much delayed Spring edition of Al Hajar has arrived. My apologies for the delay in issuing this edition of the GSO Newsletter, but circumstances beyond my control have meant that it could not be delivered until now. Along with our usual items, we have a technical article summarising the glacial record in Oman's stratigraphy, two field trip reviews (one pictorial), a review of a co-operative venture undertaken with the Geologists Association that drew the attention of the local press and an article about the GSO at the Oil and Gas West Asia Exhibition and Conference, held here in Muscat. I hope you enjoy reading this edition. As always any comments about the newsletter or contributions of articles are most welcome.

John F. Aitken
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Spudding-in of Fahud-1, 18 January 1956

50th anniversary field trip to Jebel Fahud

Excursion Leaders: Alan Heward (PDO), Volker Vahrenkamp (PDO), Peter Homewood (Independent) and Martine van den Berg (PDO)

Special Guests: Don Sheridan, Quentin Morton, Catherine Sheridan and Gill Morton

On Thursday 19 January we gathered around the Fahud-2 wellhead outside the Oil and Gas Exhibition Centre to start a unique celebration, the 50th anniversary of the spudding of the "unluckiest" wildcat well in the history of the Middle East: Fahud-1.

At first it seems that there is no reason for celebration, but moved by curiosity and explorationist enthusiasm we started by visiting the PDO core shed to look at cores from Fahud-1 and Fahud-391. The company of Don and Catherine Sheridan and Quentin and Gill Morton made this visit to the core shed special. Don Sheridan and Mike Morton were part of the Iraq Petroleum Company (IPC the forerunner to PDO) geological team that defined the Fahud-1 location, and Don has writen a book of his memories[1]. Quentin Morton is Mike's son. Alan and Volker made us understand that Fahud-1 had just missed an accumulation of more than 6BBO by a distance of less than 200m. It only penetrated a thin section of Natih G. Don Sheridan explained to us that they were only allowed to reach the Fahud area in October 1954, when the anticline was first structurally mapped and the well location identified. They only had 11 cross-sections measured and mapped by plane-table, with no evidence for what we now know as the Fahud fault, compared to modern 3D seismic and more than 3km of core. Before heading to wadi Mi'aidin we enjoyed coffee, tea and a birthday cake designed by Felicity Heward which was not only beautiful but also delicious.

Volker explaining to us why Fahud-1 missed it and what we have learned from it

The birthday cake.
Photo courtesy of Gordon Forbes

In the field season of 1956/57 the geologists were hoping to find rocks in Wadi Mi'aidin similar to the ones being drilled in Fahud-1. However Suleiman bin Hamyar, the Lord of the Green Mountain and Beni Riyam State, after many negotiations, only allowed Mike Morton (Quentin's father) a very short walk into the wadi, at gun point, in which he could superficially recognize the rocks he saw but could not possibly appreciate the significance of the Cretaceous rocks in Wadi Mi'aidin, where more than 200 m (Natih A to G) are exposed, compared to the 27 m (Natih G) penetrated in Fahud-1. Salim, from Shuram, explained to us how powerful the Suleiman bin Hamyar family still are in the area.

We then sat comfortably on red chairs surrounded by the magnificent Cretaceous outcrops in Wadi Mi'aidin

[1] Sheridan, D. 2000. Fahud, the Leopard Mountain: exploring for oil in Oman and Libya in the 1950s. Vico Press. 256pp.

Spudding-in of Fahud-1...

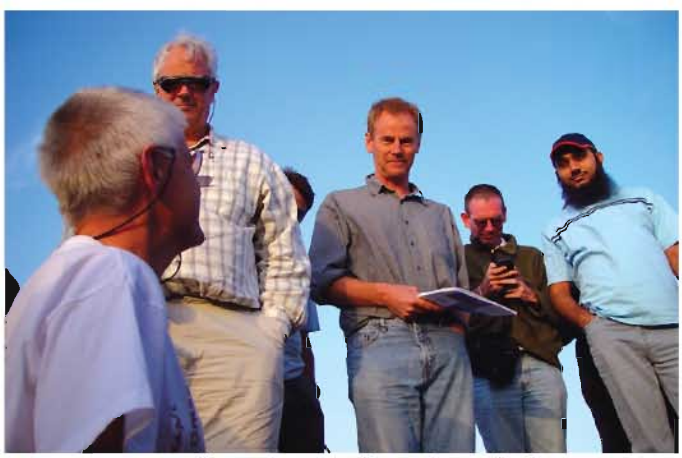
Don Sheridan giving us the geological reasons for the locationof Fahud-1

Don sharing with us why they wanted to get access to Wadi Mi'aidin

and had a light lunch prepared by Shuram. Towards the middle of the afternoon we arrived at the location of Fahud-1 where we had our group picture taken. We then drove about 2km to the southeast from Fahud-1 to look at ENE-WSW orientated, calcite-filled veins cutting the main regional seal formed by the Fiqa marls. "Are these calcite veins related to the NE-SW compression that created Jebel Fahud?", Alan asked. Jean Paul immediately disagreed and related them to more probable strike-slip movements. Recent thin-sections from these calcites show the presence of primary fluid inclusions that may contain hydrocarbons.

We camped overnight in the vicinity of the old IPC/PDO campsite, where Alan and Felicity had collected from a previous visit to the site, cigarette tins and beer bottles left behind by the original drilling crew. We had a great dinner prepared by Shuram and before bed time we watched a slide show prepared by Quentin and a movie (some of us half slept at this time, some others freezing because of the strong wind) prepared by Peter Walmsley about the IPC DEF expedition and the Fahud-1 drilling. Don later explained in detail that the DEF expedition took place from 1949 to 1952 and had the main target of reaching the Fahud area to determine whether the flexures of the rock observed in the aerial photographs (Jebel Fahud anticline) had been caused by tectonic folding or by an igneous intrusion.

The next morning, Friday 20 January, we started the day visiting the outcrops of the Paleocene Umm er Radhuma (UeR) upper boulder beds adjacent to the camp site. We then went to visit the main topography of Jebel Fahud created by the resistant upper and lower boulder beds of the UeR limestones. This was a great place to overlook the Fahud-1 and Fahud-16 wells despite the strong winds. We all learned from Alan's experience how difficult it is to drill through these boulder beds, which, by the way, are not real boulders but large concretions, since they induce huge mud losses. Large (2 to 15 cm), irregularly shaped vugs could easily be observed in the field, these vugs are lined with calcite crusts that under the microscope are zoned, and contain black, possibly organic, growths of manganese. "Are these calcite crusts related in some way, or not at all, to the calcite filling the veins that cut the Fiqa



We really enjoyed Alan's knowledge.
Photo courtesy of Jan Schreurs

Spudding-in of Fahud-1...

Formation?". A good question by Alan and a good topic, as well, for a MSc degree, anyone interested?

When we arrived at the Fahud Field, gathering previously at the Natih roundabout, Saud introduced us to the present day Fahud field. Some 400 wells have been drilled, the Fahud surface area is covered with flow lines and production facilities, however only 17% of the original oil in place has been recovered to date. The main recovery mechanisms have been primary depletion, water flooding and gas/oil gravity drainage. "A lot of oil is still in the ground!", exclaimed Volker, this is why there a large group of geologists, engineers and researchers engaged in shaping the future of Fahud. Possible solutions include optimisation of existing production mechanisms, steam injection and even open pit mining is possible. "Mining may sound like a crazy idea", continued Volker, however coal is mined at similar depths in Germany. Anyone interested in buying some property in the future Fahud Lake resort area?

Calcite filled veins crosscutting the main regional seal of the Fiqa Formation

All of us in Fahud-1 location.
Photo courtesy of Badar Al Barwani

I was lucky enough to share Gordon's car with Don and Catherine on the trip. Sitting in the back seat I could see the emotional eyes and red face of Don as we drove through the facilities of the Fahud Field, when at the same time he was saying, "It never occurred to me 50 years ago, that I would one day be driving through one of Oman's giant oil fields, the Leopard Mountain, Fahud Field".

We ended this fascinating experience with a very emotional occasion when Quentin Morton, son of Mike Morton and the sons of Aziz (the first Duru and Omani PDO employee first as a rod man and later as a driver), met for the first time in the Nizwa hotel. We drove back to Muscat after having a traditional Omani lunch.

I would like to thank GSO and the field trip leaders for organizing such a unique Field Trip and the Oil North

Lower Boulder bed of the middle UeR Formation.
Photo courtesy of Jan Schreurs

Spudding-in of Fahud-1...

Natih Formation (E to A) in Wadi Mi'aidin is more than 200 m thick

Flow lines cover Jebel Fahud, taking oil from the wells to centralised facilities

and Exploration Directorates of PDO for jointly sponsoring the trip. 50 years later I consider that Fahud-1 was not the "unluckiest" well after all, it was just teaching us a lesson as Wallace E. Pratt said in 1952, "Where oil is first found, in the final analysis, is in the minds of men" and all Fahud geologists have proven it!

Xiomara Marquez (PDO)

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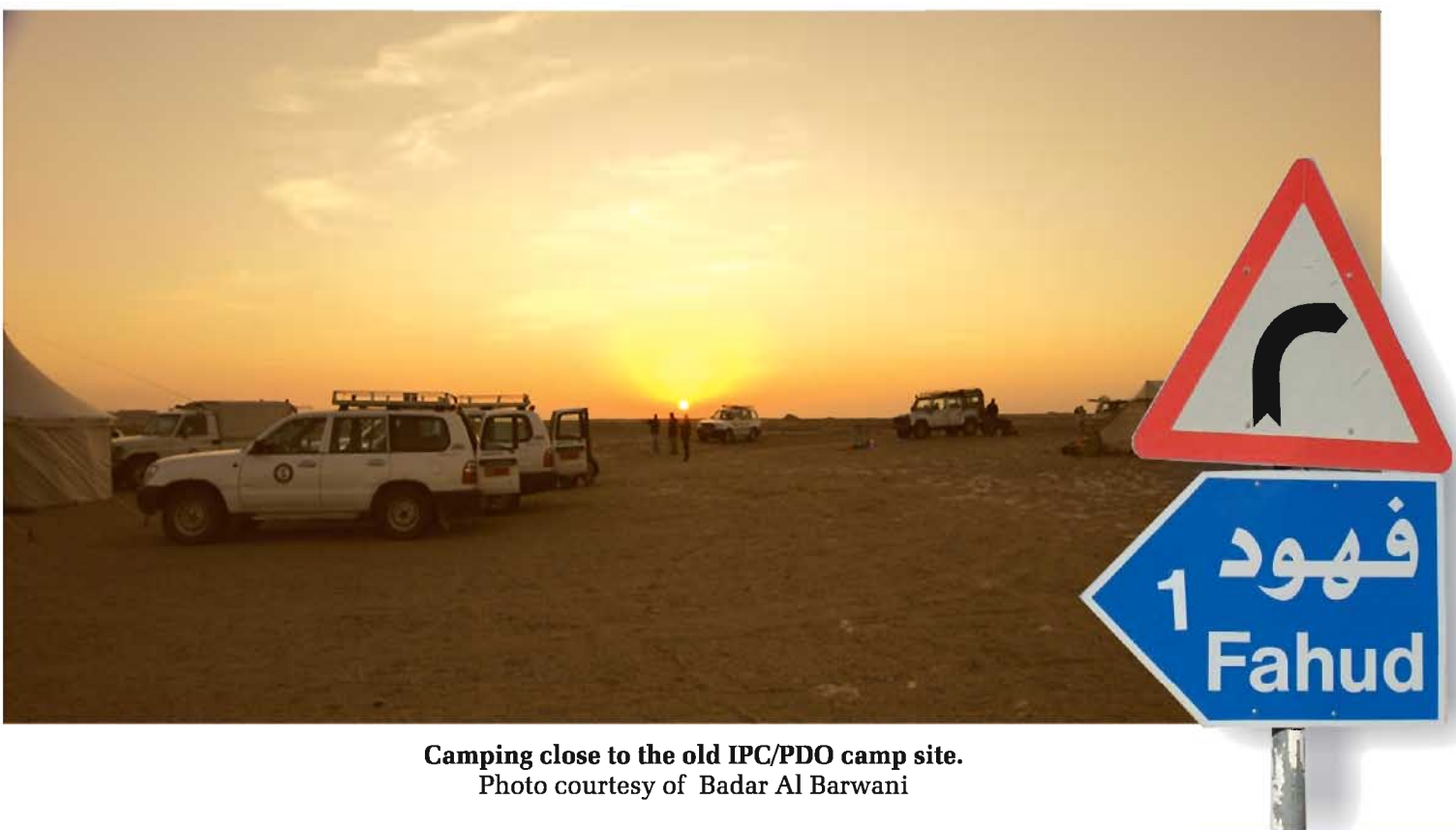
OIL NORTH AND EXPLORATION DIRECTORATES

Quentin Morton and Don Sheridan meeting Azziz's Family (Mike Morton and Azziz in the framed photograph more than 50 years ago)



Camping close to the old IPC/PDO camp site.
Photo courtesy of Badar Al Barwani

ICE COLD IN MUSCAT: OMAN'S FROZEN PAST

John F. Aitken (Petroleum Development Oman)

As the weather begins to heat up into the Arabian summer it is hard to imagine that Oman has been subject to the influence of arctic conditions and on several occasions may have looked similar to Figure 1. However, it is true that Oman has been influenced by glaciers and ice sheets in the past and the evidence for this is abundant in the Sultanate's geological record. The earth appears to have suffered globally impacting glaciations on five separate occasions (for further details see Eyles 1993):

- in the early Precambrian, approximately 2500 2000Ma ago;
- in the late Precambrian during the Sturtian and Vendian, some 800-600Ma ago;
- in the late Ordovician and early Silurian, approximately 450Ma ago;
- in the Permo-Carboniferous, around 300Ma ago;
- in the Pleistocene, over the last 2Ma.

Of these only three have left evidence in Oman, the late Precambrian, Sturtian and Vendian glaciations, the late Palaeozoic Permo-Carboniferous and the Pleistocene glaciations. Although parts of Arabia were glaciated during the Ordovician (eg. McClure 1978, Vaslet 1990), no unequivocal evidence of late Ordovician-Silurian glaciation, has been discovered in Oman. It would appear that at this time Oman lay south of the glaciated region.

This short article introduces the evidence for the influence of glaciation in Oman and briefly reviews the Precambrian Huqf Supergroup, Abu Mahara Group, the Permo-Carboniferous Al Khlata Formation and the Pleistocene evidence for the impact of high latitude glaciation.

Precambrian

The oldest glacigenic sediments in Oman are those of the Precambrian (Neoproterozoic) Abu Mahara Group (Huqf Supergroup), that occur in outcrop in the Jebel Akhdar (eg. Leather 2001, Leather et al. 2002, Allen et al. 2004) and at Mirbat in Dhofar (eg. Qudwai et al. 1988, Kellerhals & Matter 2003), as well as in the subsurface (eg. Gorin et al. 1982). Three formations occur that are related to glaciation (Fig. 2). The oldest, the Sturtian age Ghubrah Formation, is overlain by the Ghadir Manqil Formation (Fig. 2), of probable Maronian age (Leather 2001). The base of the Ghadir Manqil Formation comprises the basaltic Saqlah Member, overlain by the dominantly glacigenic sediments of the Fiq Member, which in turn is overlain by the carbonates of the Hadash Formation. These

Figure 1: The Russell Glacier and outwash stream, west Greenland, July 1988. Oman's scenery may have looked similar to this in the geological past.

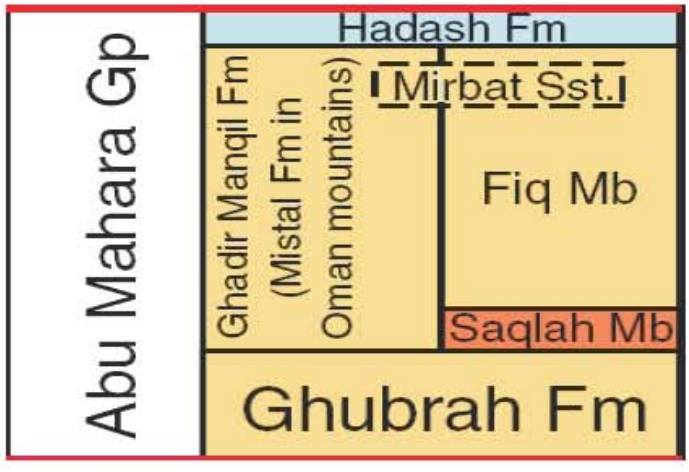


Figure 2: Outcrop-based stratigraphy of the Neoproterozoic Abu Mahara Group (modified after Leather 2001)

ICE COLD IN MUSCAT...

glacigenic deposits are part of the succession from a period when there may have been global glaciation, commonly referred to as "Snowball Earth" (eg. Hoffman et al. 1998).

Figure 3: Close up of a granite clast in a diamictite, illustrating deformation of underlying laminae and draping by overlying laminae, strongly suggesting the origin of this clast as a dropstone from floating ice.

The glacigenic sediments comprise a complicated mixture of diamictites, conglomerates, sandstones, mudrocks and volcaniclastics (eg. Leather, 2001). Stratified and massive, clast-rich and clast-poor diamictites are dominant. The matrix of the diamictites is typically muddy and clasts comprise different lithologies. Clasts commonly deform or penetrate underlying laminae and are typically draped by overlying laminae (Fig. 3). Fine- to coarse-grained sandstones commonly grade upwards into rippled sandstone and siltstone. These in turn may grade upwards into massive and laminated mudrocks. Thicker successions of mudrock (10s of metres) commonly occur intercalated between diamictite. These deposits are interpreted as glaciomarine. Diamictites are interpreted to be rainout in origin, with clasts dropped from floating ice. Sandstone lithofacies are interpreted to represent shallow marine, probably ice proximal, deposits and non glacial debris flow and shallow marine successions. On the basis of the presence of non-glacial deposits and stratigraphic data it has been proposed that the Fiq Formation was more similar to the Pleistocene glaciations and throws doubt on "Snowball Earth" (eg. Leather 2001, Leather et al. 2002).

The Hadash Formation (Fig. 4) is thin, (maximum thickness c.15m) and comprises dolomitic microspar interbedded limestone and dolomite and sandstone. It's base marks a significant change in climate and

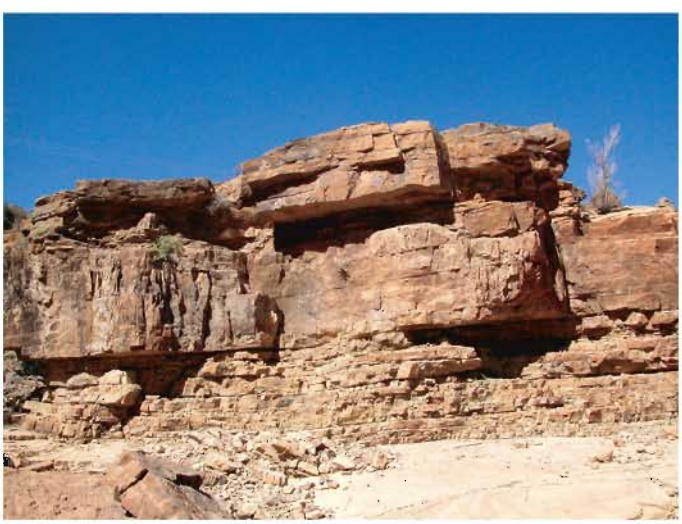


Figure 4: Dolomites of the Hadash Formation, near Hadash, Wadi Mistal.

Figure 5: Glacial grooves in the Precambrian Khufai Formation, Al Hindi Pavement, southern Huqf. The only evidence for the direct action of ice in the Permo-Carboniferous Al Khlata Formation

ICE COLD IN MUSCAT...

depositional environments, immediately following the glacigenics of the Ghadir Manqil Formation and is interpreted to represent deposition in relatively deep water probably linked to post-glacial sea-level rise (Leather 2001).

Permo-Carboniferous

Probably the best known glacial succession in Oman is the Permo-Carboniferous Al Khlata Formation (Haushi Group) that occurs in outcrop in the southern Huqf (eg. Braakman et al. 1982, Levell et al. 1988, Al Belushi et al. 1996, Angiolini et al. 2003) and extensively in the subsurface, where it hosts significant hydrocarbon reservoirs (eg. Levell et al. 1988, Osterloff et al. 2004). Unlike the Precambrian glacial deposits, the Al Khlata Formation contains no evidence for glaciomarine conditions and is a purely continental glacial succession.

In outcrop, the Al Khlata Formation overlies glacially grooved pavements in the underlying dolomites of the Precambrian Khufai Formation (Fig. 5) and comprises a complex package of clastic lithologies that include diamictite, conglomerate, pebbly sandstone, sandstone, siltstone and silty shale, the latter often

Figure 6: Large outcrop of bedded pebbly sandstones and sandstones interpreted to have been deposited in glaciofluvial braided rivers, possibly as delta top deposits, Wadi Al Khlata North, southern Huqf.

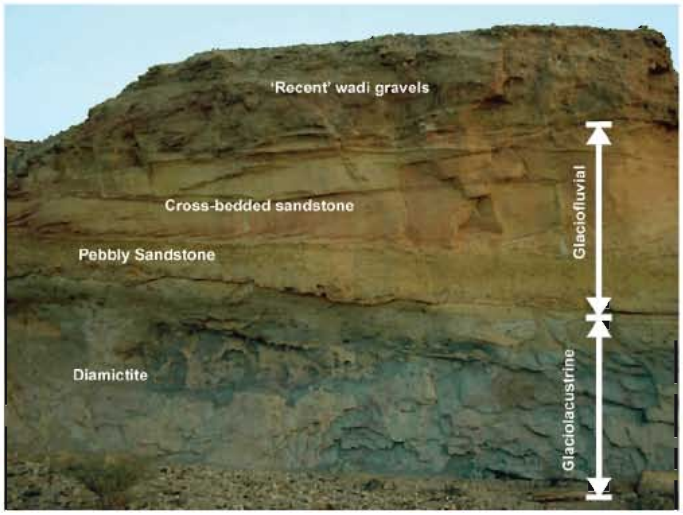


Figure 7: Diamictite of glaciolacustrine rain-out origin overlain by glaciofluvial pebbly sandstones and cross-bedded sandstones, Wadi Al Khlata South, southern Huqf

displaying 'varve-like' rhythmic laminations (Figs 6, 7 & 8). Diamictite contains clasts up to boulder-size that are commonly far-traveled (granites and volcanics) interpreted to have been dropped from floating ice. Glaciodeltaic and glaciolacustrine deposits are volumetrically the most significant environments present, which is taken, along with other lines of evidence, to indicate that the Al Khlata Formation consists predominantly of deglacial successions deposited in proglacial and possibly ice marginal settings. Except for the occurrence of the ice-grooved pavements, ice contact deposits or other direct indicators of glacial ice, have not been recognised.

Pleistocene

During the last two million years the northern and southern hemispheres have endured numerous glacial periods. You might think that the effects on Oman, more or less on the Tropic of Cancer, would have been minimal. This is not the case, because with the build up of ice, global sea levels fell (by as much as 130m during the last glaciation, eg. Fairbanks 1989) and winds were stronger.

The most obvious impact of this is within the capital area and banked against the coastward side of the

ICE COLD IN MUSCAT...

Oman Mountains where the Tertiary carbonates are covered by the remnants of a previously more extensive cover of Pleistocene, carbonate-rich, cemented, aeolian sandstones (Al Belushi 1998, Glennie & Gokdag 1998). These dunes (Figs. 9) are of various ages and bedding within them indicates a northerly to north-westerly transport direction. Furthermore, they dip below present sea level. Taken together, this implies that the sediment source for the dunes now lies beneath the sea on the Gulf of Oman and shows that they were deposited when sea level lay many 10s of metres below present, suggesting that these are glacially influenced deposits (Glennie & Gokdag 1998).

Figure 8: Deformed silty sandstones and sandstones in Wadi Al Khlata South, southern Huqf. These are interpreted to represent slumping and mass movement on glacially influenced delta fronts.

Conclusion

As we enjoy the pleasant winter weather and before the unbearably hot summer begins, it is hard to believe that the Sultanate has on numerous occasions been a frozen waste, but it is true. Ice cold in Muscat, indeed (Fig.10)!

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Figure 9: Large-scale aeolian cross-bedding in cemented Pleistocene sandstones, Public Technical Library, Mina al Fahal, Muscat

ICE COLD IN MUSCAT...

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Figure 10: The Greenland Icesheet with nunataks (mountain peaks) protruding through the ice. Was this how the Sultanate once looked?

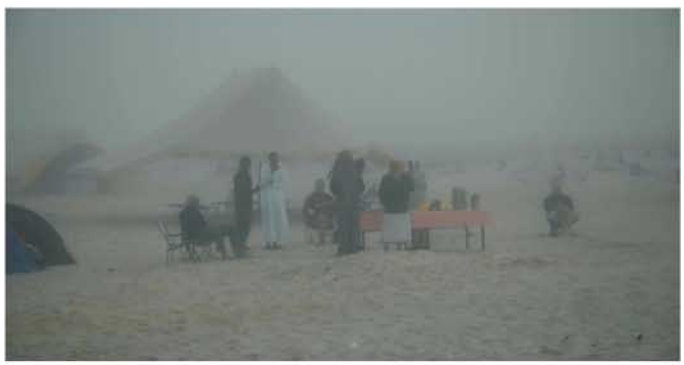
Geology of Bar Al Hikman, A modern Carbonate Analogue

Excursion Leaders: Peter Homewood, Monique Mettraux & Volker Vahrenkamp
Photos: Badar Al Barwani (Occidental Oman)

Intruders

Walking on salt

The sea was at this level, just use a bit of imagination



Breakfast at dawn

The Group

A bit of Geology

Sunset at camp

Driving at the bottom of the sea, this was under water 6000 years ago

Geologists Association visits Oman

assisted by the Geological Society of Oman

Twenty one geotourists from the UK-based Geologists Association (GA) had a two week long geologically focussed holiday in the Sultanate, assisted by the GSO. This was the second visit by the GA to the Sultanate and it attracted the attention of the local press with a full page article appearing in the Oman Daily Observer Features Section on February 5th. The visit has opened up further co-operation between the GA and the GSO.

The GSO were delighted by the GA's choice of the Sultanate as a holiday destination focusing largely on the country's unique geological heritage with the visit representing a strong endorsement of Oman's potential as a market for geo-tourism, and opening up possibilities for cooperation between the two groups in areas such as geo-conservation and the setting up of geo-parks. The GA has offered support for GSO initiatives in geological conservation, especially the plans for a Geological Museum.

GSO ran a series of field trips to introduce the visitors to Oman's geological heritage. The first day focused on the 'Semail Ophiolite and the visitors learned about the formation of the ophiolite and the Oman Mountains. The second day also concentrated on the ophiolite, giving the visitors a more detailed look at pillow lavas, sheeted dykes and yellow limestones of the Al Khoudh area. On the third day, the group visited Wadi Bani Kharus some 600 million years of time is represented and the mainly carbonate rocks that comprise the major oil reservoirs in Oman were examined. The party were then taken to Jebel Akhdar where they were driven over the anticline from Wadi Bani Awf to Nizwa, giving the visitors a complete insight into how the mountains were formed. In the Nizwa area, Wadi Mi'aidin was visited and the Mesozoic carbonate successions were examined. The group then spent a few days in the Empty Quarter (Rub al Khali) examining modern dunes, a theme that was continued with a visit to the Wahiba Sands. The holiday ended with a trip to the Sifah and Yiti areas where folded and deformed rocks yield further evidence to the formation (and deformation) of the Oman Mountains.

Journeying back into geological history

A group of British tourists representing the London-based Geologists Association, the world's oldest and most respected fraternity of geologists, recently concluded a fortnight-long tour of Oman's spectacular geological attractions. The visit bodes well for efforts to put Oman on the geo-tourism map, says the head of the Geological Society of Oman

By Conrad Prabhu

(Right to left) Dr Omar al Ja'aidi, President of the Geological Society of Oman (GSO); Nigel Brown, Chairperson of Rockwatch; Roger Dixon, Vice-President of the Geologists Association; and Adil al Kiyumi of the GSO

Folded carbonate rocks in Wadi bani Auf

A portion of the front page of the Oman Daily Observer's Feature Section, February 5th, 2006

GSO INTERNATIONAL NEWS

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INDIA

What may well be the last bid round under the New Exploration Licensing Policy (NELP), at least in its present form, is to be launched in late February or early March 2006. Tentatively, NELP VI will offer 45 to 48 blocks that have been identified by the Directorate General of Hydrocarbons (DGH): 19-22 onshore blocks, two shallow water blocks, four deepwater blocks and 20 ultra-deepwater blocks. Meanwhile, the government is considering proposals to amend the terms to encourage greater foreign participation and investment in the upstream sector. Ultimately, plans are to move away from the offering of exploration blocks under the NELP in favor of an open acreage system.

IRAN

Announcements of a major gas find by NIOC on Kish Island remain to be confirmed by the early tests, which, sources indicate, have so far failed to flow gas. The well has been drilled to a depth of 4,400m and testing of an interval at around 4,100m incurred no positive results. Similarly, two earlier tests over the perforated intervals between 3,970-3,979m and 3,986-3995m, also failed to provide positive results. The well was spudded on 31 December 2004 seeking objectives in the Permian to Triassic Khuff equivalent, Kangan and Dalan formation carbonates and underlying Faraghan Formation clastics. NIOC's Director of Exploration, Seyyed Mahmud Mohaddes, announced to the Iranian press on 14 December 2005 that gas had been found on Kish Island but did not speculate on the size of the discovery, and said that following further testing and analysis, reserve estimates are due to be released in mid-February 2006. However, his deputy, Hossein Roshandel, had earlier predicted that field has huge gas reserves with the Iranian press reporting that a "massive" gas reservoir had been penetrated. The previous well on the structure, Kish 1, was drilled in 1968, and was abandoned dry at depth 2,621 m, while still in the Jurassic.

IRAQ

Providing an update on its first well in the Kurdistan region, Norwegian explorer DNO has reached its first prospective reservoir in Tawke 1 at a depth of 350m. Sources indicate the well flowed 24°API crude at a rate of 300 barrels per hour. DNO is now proceeding to drill the reservoir section prognosed to be up to 800m thick. The well has a planned total depth of 3,000m, with objectives in three zones.

KUWAIT

In the vicinity of what was hailed as the first oil discovery in the country from the Lower Marrat Formation, KOC says it has found gas and condensate in its Raudhatain Northwest 2 (NWRA 2) exploratory well. Located onshore in the Dibdibah Sub-basin, the well was drilled to a total depth of 6,090m seeking objectives in Jurassic Marrat and Najama/Sarjelu formations and Permian pre-Khuff and Khuff formations. It is reported that a test in the Sarjelu formation flowed 5,100 b/d of a 47°API condensate with a GOR of 4,100 Scf/b at the depth of 4,420m. KOC's first Lower Marrat Formation discovery in the north of the country was NWRA 3, which was suspended in May 2004 for further testing.

PAKISTAN

Lower Indus Basin acreage relinquished by BP in November 2004 has been awarded to Petroleum Exploration (Pvt) Ltd (PEL) in the form of two exploration licenses: the 1,246 sq km Badin IV North 2468-6 EL and the 1,265 sq km Badin IV South 2468-6

GSO INTERNATIONAL NEWS

EL. The acreage is in the Badin, Thatta and Hyderabad districts of the Sindh province. The work programs for the initial three year exploration phase is believed to include G&G studies and 150km 2D seismic acquisition for each EL plus the drilling of three exploration wells on the north license and four in the south. A minimum financial commitment of US$ 11.15 million was drawn-up for both licenses.

Meanwhile, Sulaiman Foldbelt acreage that had been applied for by OGDC has been granted to PPL. Apparently, PPL made a higher counter offer for the 2,104 sq km Barkhan EL. Commitments include G&G studies, 200km of 2D seismic and three exploration wells.

QATAR

In the company's latest release about operations, Anadarko confirms that its proposed 3D survey in the 3,097 sq km Block 4 will now be shot in the 2nd Qtr. '06. This survey, which may extend up to 1,810 sq km, was originally scheduled for 4th Qtr. '05. Anadarko signed the Block 4 oil and gas Exploration and Production Sharing Agreement (EPSA) with Qatar Petroleum (QP) on 18 May 2004. During the initial five-year exploration phase, work commitments include seismic reprocessing, acquisition of 2D and 3D data and exploratory drilling. Anadarko holds a 100% interest in the concession. Elsewhere, on the 686 sq km offshore Block 13, Anadarko plans a 1st Qtr. '06 spud of its Fasht Al Dibal 1 (FAD-1) wildcat. This well will seek Cretaceous and Jurassic objectives and has a planned total depth of 2,590m.

SAUDI ARABIA

The LUKSAR consortium (Lukoil 80%, Saudi Aramco 20%) spudded Takhman 3 in January 2006, its first well on the 29,900 sq km onshore Contract Area A in the northern part of the Rub al-Khali desert. Takhman is ranked as the largest structure in the acreage and the well, with a planned total depth of 5,000m is targeting Paleozoic gas accumulations in the Permian, Unayzah and Devonian, Jauf formations. Saudi Aramco drilled the Takhman 2 discovery in 2002, effectively ending IOC interest in Core Venture 1, for which ExxonMobil were negotiating as part of the first Saudi Gas Initiative. Located 160km west of the super-giant Ghawar field, Takhman 2 tested 3,470 b/d of 40° API oil and 4 MMcf/d of sweet gas through a one-inch choke. Area A is believed to carry a maximum 10-year exploration phase (divided into three periods). The first five-year exploration period carries a minimum commitment to acquire 4,000km of 2D seismic and drill two exploration wells, following which there will be a 50% acreage relinquishment. A second three-year optional period carries a further minimum commitment, which includes 2,000km of 2D seismic and two exploration wells, following which there will be a further 50% acreage relinquishment. The third and final two-year exploration period carries a minimum commitment to drill two exploration wells. In the event of a commercial discovery, the Saudi Arabian government will pay for the construction of a gas pipeline from the gathering station within the contract area to the country's Master Gas System (MGS), subject to a minimum supply volume of 350 MMcfg/d.

SYRIA

Having met the seismic obligation for Block 26 in the Sinjar Trough in north-eastern Syria, Gulfsands Petroleum has now signed letters of intent with MB Drilling for two rigs to drill the first two of the four exploration wells that are to be completed by the end of August 2007. The first prospect is Suwaidiyah North which is to spud in early May 2006. With a planned total depth of 2,200m, it is to be drilled by MB "Rig 21,"

GSO INTERNATIONAL NEWS

seeking a primary objective in the Cretaceous with around 100 MMbo recoverable. The second prospect, Tigris 1, is also located in the north-east portion of the block and will be drilled by MB "Rig 6" to around 4,500m, with the primary objectives being a series of Carboniferous and Devonian sandstone reservoirs. This well is expected to spud in late-August 2006 and has a potential 500 MMbo recoverable. The Tigris structure is directly underlying the largest producing oil field in Syria, the Suwaidiyah field where oil is produced from the shallower Cretaceous reservoirs. Gulfsands says the re-evaluation of wireline logs of an existing well on the structure drilled some years ago has identified potential hydrocarbon bearing zones within the objective reservoirs. The Tigris exploration well will evaluate these reservoirs and appraise this potential hydrocarbon accumulation. In November 2005, UK independent Emerald Energy paid US$ 16.9 million to acquire the 50% held in Block 26 by Soyuzneftegaz and now shares the permit equally with Gulfsands.

TURKEY

With bad weather preventing the testing of the consortium's first well, joint operators Merty Energy (10%) and Petrako Ltd (10%) spudded their second well, in block 3839, District I, in the Thrace-Gallipoli Basin on 13 January 2006. Arpaci 1 has a planned total depth of around 500m and will be followed by a well on the nearby Koyustu structure. The first well, Bati Umur 1, suspended late December 2005 at a depth of 1,052m, provided some encouragement. Gas was indicated on logs at three intervals; 363-370m (coinciding with the main amplitude anomaly), 413-416m (main objective) and 878-880m (secondary objective). Testing of this well is scheduled for the second half of 2006. Australian companies Erdine Energy (65%), a wholly owned subsidiary of Ottoman Energy, and Incremental Petroleum Ltd (15%) hold the remaining interests in this block.

YEMEN

DNO says that it is preparing to drill an exploratory, down-dip sidetrack of its Godah 1 wildcat within the 598 sq km onshore Hoowarime (Development) Block 32. Drilled to a depth of 1,712m, logs, pressure and fluid data indicate the presence of oil and gas in the Lower Cretaceous Qishn S1A sandstone. It is hoped the sidetrack will penetrate a full oil-bearing section prior to production testing. The well lies 7km east of the Tasour oil field, which at the end of 2005 was producing an average 10,300 bo/d. Should a test confirm commercial oil flow, the well will be tied back to the Tasour main CPF facilities. Prior to spud, partner TransGlobe Energy reported the well had possibilities of finding around 15 MMb of recoverable reserves.

MOL has completed its 350km 2D seismic survey in the 5,055 sq km onshore (North Mukalla) Block 48 concession from which it is understood three prospects have been identified. The company is drawing up plans to drill an exploratory well in the 4th Qtr. '06, ahead of which it is seeking to farm out an unspecified interest in the permit. MOL made a 25% partial relinquishment in January 2004 when it entered a two-year second exploration period which has been extended. This second period carries a commitment of 500km of 2D seismic and two wells.

With thanks to IHS Energy

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GSO in Oil & Gas West Asia Exhibition 2006.

Usama Yahia Al Kiyumi (American British Academy)

At the beginning, I had feelings of doubt about whether I should be volunteering for the Geological Society of Oman stand at the Oil & GAS West Asia (OGWA) 2006 Exhibition, and I have to admit that I was feeling a bit nervous but all went well, in the end. On the way to the Oman International Exhibition Centre, with Mr. Adil Al-Kiyumi who happens to work for Geological Society of Oman, he briefed me on what he wanted me to do and gave me a brief lesson on geology and its importance. What I learned on the way was only a sample of what I was going to learn and understand about Oman's geological heritage once I arrived in the Exhibition Centre.

Once we arrived, I helped Mr. Adil set up the equipment required for the presentation in the exhibition. After setting up, Mr. Adil showed me a couple of fossils and explained to me some of the posters that were around the stand. What struck me the most was the meteorites of Oman. I also got the chance to look at other oil and gas related companies such as ADNOC, PDO, Oxy, and Oman LNG. Furthermore I got the chance to learn about the importance of Oman's rich geological heritage which plays a big and important role for Oman as a country.

I accomplished many things during the conference, I learned a number of things about Oman's rare geology that I was not aware of. What I wanted to accomplish was understanding the world of geology and why it is important for us as Omanis to have a wider understanding in that matter. It is our country and most of the income is generated from petroleum which requires a lot of Geoscientists and Petroleum Engineers, but what I really learned during the exhibition was why it is vital to educate Omanis about geology.

You might ask why it is important, well I learned that Oman is rich in fossils/rocks/geological features that date back millions of years and which are essential for understanding Oman's past, not forgetting the importance of meteorites to Oman for these can be used to help us understand our world better and study other planets in the Galaxy. Not only do the geosciences play an important role in Oman from a scientific perspective, but they have proven to be beneficial in tourism as the country is seeking diversification to its economy, and which these rare fossils and meteorites can ensure .

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GSO at Geo2006

The GSO attended the 6th Middle East Geosciences Conference and Exhibition (Geo2006) held in Bahrain, March 27th-29th as a co-ordinator and exhibitor. The Society was represented on the Conference Technical Committee as part of a team that consisted of individuals representing various regional oil companies and regional and international geoscience societies.

At the GSO booth, in the Exhibition area, recent GSO publications and stratigraphic columns (donated by PDO) were distributed to visitors, who came, literally in their hundreds. The activities and aims of the Society were discussed around posters themed around the Society's subcommittees (Geological Conservation and Heritage, Geological Museum and Geotourism). Great interest was shown in the activities of GSO and the geology of the Sultanate, as a place for scientific research, geotourism and as an area of almost unique geology. Approximately 40 membership application forms were either filled in or taken away, so in terms of recruitment of new members this was a resounding success. Thank you to all the members (Nadia al-Abry, Harib al-Hinai, Mahmood al-Mahrooqi, Khairan al Mauly, Mohammed al-Mazrui and John Aitken) who helped staff the booth during the meeting.

Members of GSO were also involved in running an extremely successful core workshop, jointly organised by Saudi Aramco and PDO, on Permo-Carboniferous deposits of the Arabian Penninsula as a one day pre-conference event. This was attended by about 60 delegates and some striking comparisons and contrasts between the deposits of Saudi Arabia and Oman were discovered and discussed.

SULTANATE OF OMAN GEOSCIENCE PUBLICATIONS 2005

In the listing of 2005 geoscience publications in the last issue of Al Hajar, the following were inadvertently omitted. Thanks to Mike Stephenson (British Geological Survey) and Jan Schreurs (PDO) for supplying this information.

Larghi, C. 2005. Dickinsartella fauna from the Saiwan Formation (Oman): a bivalve fauna testifying to the Late Sakmarian (Early Permian) climatic amelioration along the north-eastern Gondwanan fringe. Rivista Italiana di Paleontologia e Stratigrafia 111, 353-375.

Gray, D.R., Gregory, R.T. & Miller, J.M. 2005. Comment on "Structural evolution, metamorphism and restoration of the Arabian continental margin, Saih Hatat Region, Oman Mountains" by M.P. Searle et al. Journal of Structural Geology 27, 371-374.

Gray, D.R., Gregory, R.T., Armstrong, R.A., Richards, I.J. & Miller, J.M. 2005. Age and stratigraphic relationships of structurally deepest level rocks, Oman Mountains: U/Pb SHRIMP evidence for Late Carboniferous Neotethys rifting. Journal of Geology 113, 611-626.

Li, K. & Horne, R.N. 2005. An analytical model for production-decline analysis in naturally fractured reservoirs. SPE Reservoir Evaluation and Engineering 8, 197-204.

Introducing Teachers and School Children to the Earth Sciences

The GSO has been running courses aimed at improving geology teaching skills across the Sultanate (the Continuous Education Programme) since 2002. The aims of the programme are:

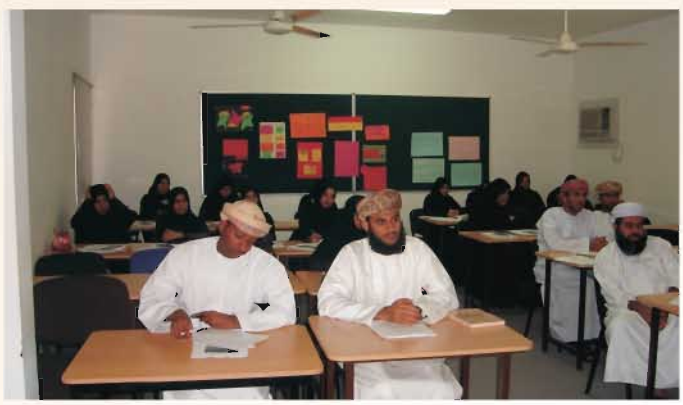
- to improve the teaching of earth sciences at basic levels of formal education and
- to emphasise the scientific and cultural significance of the earth sciences and to disseminate knowledge in this field to the young.

The program familiarises the participants with geology and, in particular, the Geology of Oman. Rocks, minerals and fossils that can be found in the Sultanate are used in the courses to introduce the participants to the geosciences. The couses have been received favourably and the number of requests for them has increased over the years. In the last year four courses have been run in:

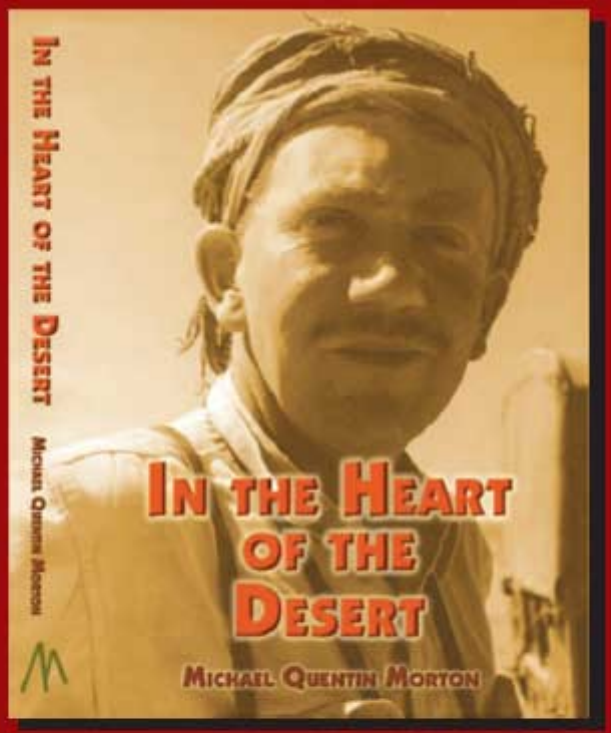
- Ibra (March 2005) with approximately 45 teachers from various part of Al Sharqia area attending;
- Fanja (February 2006), attended by more than 30 teachers;
- Muscat (March 2006) with more than 30 school teachers participating with a field trip in the Muscat area;
- Rustaq and Batinah South region (April 2006), with the largest ever attendance of approximately 200 teachers.

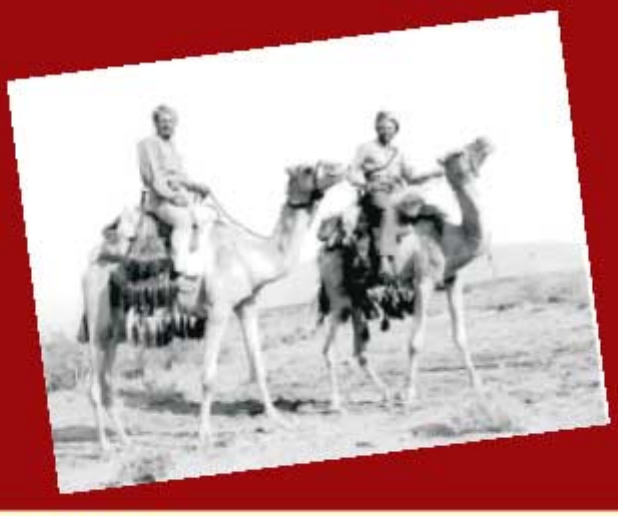
Most recently, in May 2006, at the Oil and Gas Exhibition Centre, Muscat, a new initiative for this programme was undertaken with the first course presented to elementary school children. The course was adapted to accommodate the age of the children, with an attempt to make it entertaining and fun whilst still providing a simplified introduction to sedimentary, igneous and metamorphic rocks and how to identify them. The children received this well, enjoyed themselves and asked penetrating questions. One of the teachers requested that this primary level course be repeated next year for a new group of children, which GSO will be delighted to do.

With continuing support from the Shell Representative Office Oman, the plan is to expand the programme further in coming years.



Green Mountain Press





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GREEN MOUNTAIN PRESS is pleased to announce the forthcoming publication of a new book in Spring 2006:

IN THE HEART OF THE DESERT

The Story of an Exploration Geologist and the Search for Oil in the Middle East

The decision of the British Government in 1912 to convert its naval ships from coal to oil set in motion one of the greatest periods of exploration of the twentieth century, the search for oil in the Middle East. In 1945, after a lull caused by the Second World War, exploration was set to expand again and twenty-one year old Mike Morton embarked on an empty troop ship bound for Palestine to begin his career as a geologist with the Iraq Petroleum Company.

Arriving in Jerusalem, Mike soon found himself surrounded by the Arab-Jewish conflict which led to the bombing of the King David Hotel. Then,during a series of ground-breaking expeditions in southern Arabia, he travelled where the famous Arabian explorer, Wilfred Thesiger, had feared to tread: the mysterious land of Mahra. He took part in Operation DEF, the "invasion of a foreign land", in which the interior of Oman was opened up to the modern world. Finally, in 1971, he was the deputy leader of a Royal Geographical Society expedition to one of the remotest parts of Arabia, the Musandam Peninsula.

IN THE HEART OF THE DESERT is the biography of Mike Morton written by his son. It describes an extraordinary world and a rich parade of characters: autonomous sheikhs and their fiercely independent tribes, nomadic Bedouins, colourful expatriots and a group of intrepid geologists driven by an oil company's search for oil. Mike struck a distinctive figure and, being red-haired with a sometimes fiery temper, the Bedouin called him Shaib al-Ahmar, "Angry Red Man". The author presents a detailed and thoroughly researched account of his father's life which culminates in the story of his own journey to southern Arabia and a poignant meeting of the present with the past.

70 illustrations, 28 colour photographs

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GSO EVENTS CALENDAR

2006

March

22nd March 2006
The search for petroleum in Oman - further twists in the tale
Dr. Alan Heward
Petroleum Development Oman

23-24th March 2006
From Subduction to Exhumation - Two days tectonic and metamorphic transect from Tanuf to Sifa
Dr. Jean Paul Breton

April

25th April 2006
Climate Changes, Methane Burbs, Funny Waters and the Shuaiba Formation – A Geochemical Story
Dr. Volker Vehrenkamp
Petroleum Development Oman

May

27th May 2006
GSO Annual Meeting

Copy Deadline for future Issues:

Summer 2006:
Wednesday June 7th 2006

Autumn 2006
Wednesday September 6th 2006

Winter 2006
Wednesday November 1st 2006

Spring 2007
Wednesday February 28th 2007

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